PROCEEDINGS
OF THE
NATIONAL ACADEMY OF SCIENCES
Volume 1 APRIL 15, 1915 Number 4

PHOTOGRAPHIC DETERMINATION OF STELLAR PARALLAXES WITH THE 60-INCH REFLECTOR

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Presented to the Academy, March 4, 1915

The determination of stellar parallaxes had been attempted from the days of Tycho Brahe down, but without success until Bessel in 1838 succeeded in demonstrating and measuring the parallax of 61 Cygni. Since that time the work has been advancing steadily, first with the use of the meridian-circle, heliometer, and micrometer, until in 1886 Pritchard applied photography with great success. Although several astronomers have given much time to the problem, results are still comparatively few. In 1910 Kapteyn and Weersma published a list of well-determined parallaxes, which, although nearly complete, contains only 365 stars. The accuracy of these parallaxes varies considerably; their probable errors are anywhere between 0″.004 and 0″.151, while the mean probable error is 0″.032. Since then a few lists of parallax determinations have been published, which show a good improvement; the list of Slocum and Mitchell (14 stars) has a mean probable error of 0″.011; that of Miller (8 stars) of 0″.011.

The material published so far cannot, however, help us very much in forming an idea of the distribution of the stars in space, as it is very one-sided. Most of the stars were chosen on account of their brightness or their large proper motions; but for the distribution of stars in space, it is clear, that we need as well the parallaxes of stars which are not supposed to be our nearest neighbors. But here arises a new difficulty; the quantities sought become so small, that only the greatest accuracy in their determination can give useful results. According to Kapteyn the mean parallax of a star of, for instance, the sixth magnitude and a

proper motion of 0″.100 annually is only 0″.018. It is clear that in such cases the probable error must not exceed a few thousandths of a second of arc if the results are to be valuable.

In *Contributions from the Mount Wilson Solar Observatory*, No. 79, Adams and Kohlschütter have given the absolute motions and absolute magnitudes of 100 stars with known parallaxes, for which they have determined the radial velocities. Nearly all these stars have large proper motion and are between the spectral types F and M. In the hope of completing this list by the addition of stars of the same spectral type, but of smaller proper motion, an investigation has been made to determine the accuracy with which parallaxes can be obtained with the 60-inch reflector. Although in general the method employed was that used by Schlesinger and Slocum with the 40-inch Yerkes refractor, the following deviations from their procedure may be mentioned:

The equivalent focal-length of the Cassegrain combination of mirrors employed is 80 feet, thus increasing the scale of the plates by one-quarter.

The exposure time of 15 minutes gives stars as faint as magnitude 13; by avoiding the very faintest objects visible on the plates, we can still use stars between magnitude 9.5 and 12 for comparison purposes. The fainter stars must as a rule have smaller parallaxes, so that we have here the double advantage of using comparison stars with smaller parallaxes and with a smaller mean distance from the central star.

The plates used are Seed 23, which have a fine grain; the star images therefore are sharper and the grain is less troublesome in the measuring.

The plates are measured with the blink-arrangement of the stereocomparator; two plates are compared directly without the use of any scale such as in ordinary measuring instruments. That the stereocomparator can, with some precautions, be used successfully for this kind of work was proved in a previous article (*Astronomical Journal*, **27**, 140; 1912).

Special care has been taken to make the hour angles of the two plates to be compared nearly the same. The difference in hour angle has in no case been larger than 5°, while in most cases it was less than 2°.

In comparing two plates directly we avoid in the final solution for the parallax the use of a third unknown quantity; this increases the weight of the resulting parallax.

Finally, care has been taken to make the weight of the parallaxes resulting from a certain number of plates as large as possible by distributing the exposures as symmetrically as practicable within the year.

There is, however, a difficulty sometimes affecting the use of the 60-inch reflector for this work. After a rapid change in temperature dur-

ing the time when the dome is open, the mirror occasionally shows astigmatism. Under such conditions the images are more or less asymmetrical and the measures may not be as accurate as usual. This happened with three of the exposures on the last star given in the table below.

The result of the investigation has been rather promising; 5 stars have been finished, the results of which are given in the table.

Name of Star		π	*P.E.*	*Number of Exposures*
Boss P. G. C.	96	+ 0″.026	0″.007	14
	672	− 0 .009	0 .004[5]	14
	1549	+ 0 .001	0 .001[5]	16
	2921	+ 0 .078	0 .006	10
	3233	+ 0 .003	0 .010	12

For the mean of 13 exposures the mean probable error of a parallax is not quite 0″.006. If we compare this result with the best known photographic determinations of parallaxes listed below, it will be seen that we have gained considerably.

Instrument	*Observer*	*Mean P.E.*	*Number of Exposures*
Helsingfors (11-inch)[1]	Donner, Kapteyn, de Sitter	0″.023	12
Bonn (11-inch)[2]	Küstner, Kapteyn, de Sitter	0″.020	12
Cambridge, England (12.5-inch)[3]	Russell	0″.028	27
Yerkes (40-inch)[4]	Schlesinger	0″.013	37
Yerkes (40-inch)[5]	Slocum, Mitchell	0″.011	21
Yerkes (40-inch)[6]	Slocum, Mitchell	0″.009	28
Swarthmore (24-inch)[7]	Miller	0″.011	Not published

[1] Groningen, *Pub. Astr Lab.*, 20, 28; 1908.
[2] *Ibid.*, 23, 56; 1909.
[3] *Pub. Carnegie Inst Wash.*, 147, 65; 1911.
[4] *Astrophys. J.*, 34, 27; 1911.
[5] *Astrophys. J.* 38, 25; 1913.
[6] *Pub. Astr. Astrophys. Soc. Amer.*, 16th Meeting, 19; 1914.
[7] *Ibid.*, 17th Meeting, 1914.

The material is of course insufficient to yield any information as to possible systematic errors, but we have one evidence that these can not be very large; the mean parallax is +0″.020, while according to Kapteyn's table for stars of this type, magnitude, and proper motion it is +0″.014.